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MODELING OF ELECTROMAGNETIC FIELD FROM MOBILE PHONE DISTRIBUTED IN THE HUMAN HEAD PHANTOM

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This work is a development of ideas originally presented in [1, 2]. In the work [1], a general equation for the modeling of electromagnetic field in a inhomogeneous dielectric environment was given. In the work [2], this approach was used for the hyperthermia problems solution. In our work the modeling of electromagnetic field from a mobile phone distributed in the human head phantom was carried out. The modeling was done by the integral equation method with unknown polarization currents induced by the mobile phone antenna. The induced current distribution was determined in inhomogeneous environment with complex-valued dielectric permittivity.

Existing EMC standards take into consideration thermal influence of EM fields and restrict the average specific absorption rate (SAR) in the human body. But in the case when the wavelength in biological environment is smaller then the body size, the EM-field distribution becomes irregular and its level can be higher than limit value. With increasing of mobile phone frequencies this problem becomes more and more actual.

For investigations of EM field from mobile phone distributed in the human head, a mathematical model has been elaborated. In this model development, we have modified the approach used by authors of [2] for solving hyperthermia problems.

The model used in [1] and [2], was changed according to specific radiation source. The human body electromagnetic properties were characterized by complex-valued dielectric permittivity varying from point to point. After that the problem of dielectric inhomogeneous body heating by radiation source was solved. When solving integral equation with unknown polarization currents, we used a numerical method.

As initial one, the following integral equation was taken:

$$\frac{-1}{i \cdot \omega \cdot \varepsilon} \cdot \left(\text{graddiv} + k^2 \right) \cdot \int_V \bar{J}(r') \cdot G(\bar{r} - \bar{r}') dV + \frac{\bar{J}(\bar{r})}{i \cdot \omega \cdot \left[\varepsilon_a'(\bar{r}) - \varepsilon \right]} = E^{in}(\bar{r}) \ , \ (1)$$

where $J = i \cdot \omega \cdot (\varepsilon_a' - \varepsilon) \cdot E$ is the polarization current, G is the Green's function, E^{in} is the incident EM-field amplitude.

The use of the grid method and by presenting the polarization currents as a superposition of trial functions enables us to transform integral equation (1) into linear equations system. At the first stage of the model elaboration the case of a body with constant shape and electromagnetic parameters along the Z-axis was studied. Polarization currents in every cell were characterized by piecewise-linear functions. Special features of EM field distributed in human phantom were obtained and analyzed.

REFERENCES

[1].Y.N. Vasiliev, *Applied Electromagnetics*, 1976, no 1, p. 94 (in Russian).

[2]. A. Khzmalyan, A. Chaplin, *Electromagnetic Model of Hyperthermia*, Moscow, Nauka, series Radio Engineering and Electronics, 1989 (in Russian).